CALVING GROUND SURVEY OF THE BEVERLY CARIBOU HERD, 1982

Northwest Territories Renewable Resources
Wildlife Service
The Honourable Nellie Cournoyea, Minister

CALVING GROUND SURVEY OF THE BEVERLY CARIBOU HERD, 1982

B. STEPHENSON

R. DECKER

A. GUNN

DEPARTMENT OF RENEWABLE RESOURCES

GOVERNMENT OF THE NORTHWEST TERRITORIES

YELLOWKNIFE, NWT

1984

File Report No. 28

Contents of the paper may be used only with the permission of the N.W.T. Wildlife Service.

ABSTRACT

Aerial reconnaissance surveys of the Beverly caribou calving ground were carried out between 5 to 9 June, 1982 with a Cessna 185. Most breeding females were in the same general area as in 1980 although the calving ground was smaller (4220 km^2) and extended further north to Garry Lake. Three density strata were identified and systematically surveyed by transects on 11-12 June to provide an estimate of caribou 1 year of age and older. The three areas had respective densities of 6.7, 13.6, and 18.5 caribou/km^2 from an aerial coverage of 16, 39, and 46%, respectively. The calving ground population estimate was 55,660±5,810 (S.E.). The composition of caribou on the calving ground was determined from ground observations of 3,768 caribou sampled at 53 locations in the different density strata. Breeding females comprised 77.4% and yearlings, 17.4% of the calving ground population. Females over 1 year of age comprised 62.2% of the herd as determined from a fall classification of 7,653 caribou. The total population was 124,700 ± 25,500 (S.E.).

103-05827/

TABLE OF CONTENTS

ABSTRACT iii

LIST OF FIGURES vii

LIST OF TABLES vii

INTRODUCTION 1

METHODS 2
General Reconnaissance 2
Systematic Reconnaissance 3
Systematic Survey of the Calving Ground 6
Ground Composition Counts 7
Fall Composition Counts 9

RESULTS AND DISCUSSION 10
General Reconnaissance 10
Systematic Reconnaissance 10
Systematic Survey of the Calving Ground 14
Ground Composition Counts 19
Fall Composition Counts 19
Total Population Estimate 21
Observer Bias 22
Timing of Calving 23
Observation of Other Mammals 24

RECOMMENDATIONS 25

ACKNOWLEDGEMENTS 27

LITERATURE CITED 28

APPENDIX A. Caribou numbers and densities in three Strata from the systematic survey of the Beverly calving ground on 11-12 June, 1982 29

APPENDIX B. Composition counts at 53 locations on the Beverly calving ground, June, 1982 33

LIST OF FIGURES

Figure 1. Aerial reconnaissance flight lines and survey transects of the Beverly caribou calving ground area, 5-9 June, 1982 4

Figure 2. Beverly caribou calving ground and aerial survey transects in each of three density strata 8

Figure 3. Distribution of different density components of the Beverly caribou calving ground population as determined from aerial surveys on 11-12 June, 1982 17

LIST OF TABLES

Table 1. Caribou counted on each transect during the systematic reconnaissance survey of the Beverly caribou calving ground on 8-9 June, 1982 12

Table 2. Caribou numbers and densities in the three strata from the systematic reconnaissance survey of the Beverly caribou calving ground on 8-9 June, 1982 13

Table 3. Beverly caribou calving ground population estimate based on the systematic reconnaissance survey, 8-9 June, 1982 15

Table 4. A comparison of the density per stratum between the reconnaissance and systematic surveys of the Beverly herd, 1982 16

Table 5. Beverly caribou calving ground estimate based on the systematic survey of three density strata, 11-12, June, 1982 18

Table 6. Sex and age composition of caribou sampled on three strata on the Beverly calving ground, 12-16 June, 1982 20

Table 7. Percentages of breeding cows, non-breeding cows, yearlings, and juveniles on the Beverly calving ground, 12-16 June, 1982 20

INTRODUCTION

Population estimates of the mainland barren-ground caribou (*Rangifer tarandus groenlandicus*) herds in the Northwest Territories are obtained biannually by combining results of an aerial spring calving ground census, a ground composition count on the calving ground and a fall herd-composition count. Recent surveys were conducted on the Beverly caribou calving ground in 1978 (Heard and Decker 1980) and 1980 (Gunn and Decker 1982). This report presents the results of the 1982 Beverly calving ground surveys conducted in June and incorporates the results of the fall composition counts obtained in late October and early November 1982.

To evaluate the accuracy of visual surveys and to reduce the amount of low-level flying over the calving grounds, an aerial photographic survey was also carried out on the Beverly herd in 1982. The results of this survey will be reported separately after the photo interpretation has been completed.

METHODS

The aerial calving ground survey consists of three components; 1) a general reconnaissance of the previously known calving grounds and adjacent spring migration routes to establish the general location of the calving ground, 2) a systematic reconnaissance of the general calving ground area to establish the boundaries of the calving ground and relative caribou densities, and 3) a systematic survey of the different density strata within the calving ground to obtain a population estimate and a measure of its precision.

General Reconnaissance

On 3 June, Bob Decker and Bruce Stephenson left Yellowknife in a Cessna 185 piloted by Norm Zigarlic of Loon Air, Fort Smith. We intended to fly over the Beverly caribou spring migration route from east of Great Slave Lake to the Thelon River and commence our reconnaissance survey in the vicinity of Ursus Islands. We flew directly to Fort Resolution but were unable to land to refuel from our reserve because of deteriorating ice conditions. We then continued in a straight course to Warden's Grove on the Thelon River, however, the ice had left the river so we had to forego any reconnaissance flights because of limited fuel and fly directly to a base camp at Itza Lake (65°02'N, 98°27'W) northeast of Schultz Lake. A field-camp had been established at Itza Lake by Anne Gunn, and Frank Miller (Canadian Wildlife Service) for their research studies on the Beverly caribou calving ground. The pilot

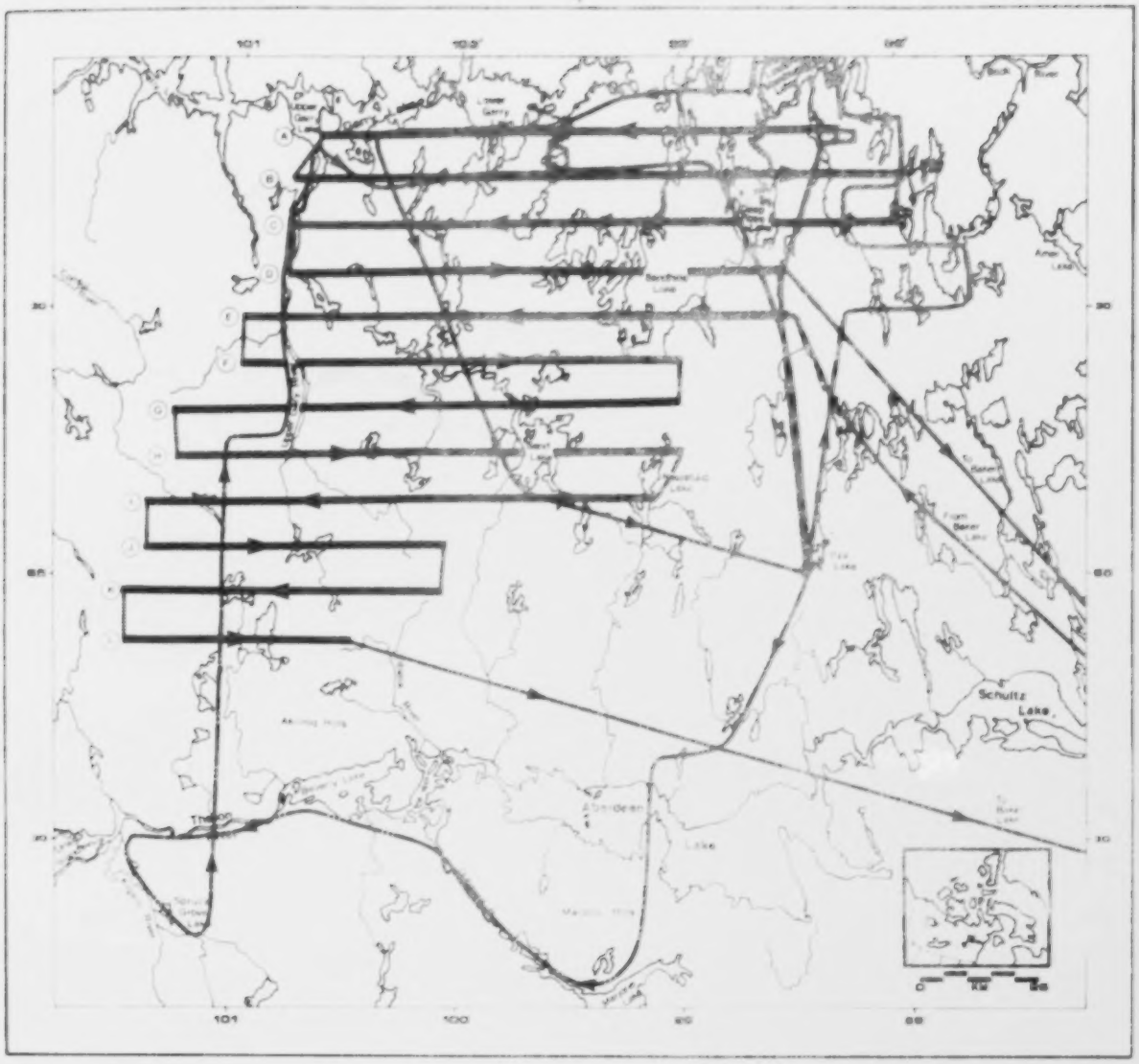
and Anne Gunn later flew to Baker Lake to pick up an H.T.A. observer, Gibson Taipana, to participate in the aerial surveys.

Adverse weather conditions prevented flying on 4 June but favourable conditions prevailed on 5 June. One flight went south to Aberdeen and Marjorie Lakes, along the Dubawnt River (which was ice-free), west along the Thelon River as far as Ursus Islands, south to Spruce Grove and then north to Upper Garry Lake, east to Deep Rose Lake and back to Itza Lake (Fig. 1). A second flight covered the area east of Deep Rose Lake and south of Garry Lake and passed through the centre of the caribou concentration between Garry Lake and Sand Lake. Both flights were made at an altitude of 120-170 m and an airspeed of 175 km/h. The ground was about 80% snow covered.

The two rear observers recorded observations of all wildlife on separate tape recorders according to consecutive observation numbers. The observers maintained communication with the pilot by an intercom system and the pilot located each observation number on a 1:250,000 scale map. After every flight the observations were transcribed to standard flight forms.

Systematic Reconnaissance

Heavy overcast, snow and moderate winds prevented flying on 6 and 7 June. The hard packed snow ridges on Itza Lake made landing conditions marginal for the ski-equipped Cessna so the pilot decided that future flights would have to be made from the air-strip at Baker Lake with refuelling at a gas cache on Sand Lake.



Legend

Flight lines (non-systematic reconnaissance, June 5)

Flight lines (to and from systematic reconnaissance)

Transects (systematic reconnaissance, June 8-9)

Figure 1. Aerial reconnaissance flight lines and survey transects of the Beverly caribou calving ground area, 5-9 June, 1982.

Wing-strut markers made from a 1.3 m cord with a 15 cm terminal cardboard cone, were taped to each strut to approximate an observation zone of 400 m from a flying height of 122 m (400 ft). The exact locations of the markers were determined by repeated flights over two 45 gallon drums placed 400 m apart and on landing the wing-strut markers were adjusted accordingly.

The general reconnaissance flights established the north-eastern and northern boundaries of the caribou concentrations and approximated the western and southern boundaries. Observations made by the research team while placing their field camps near Deep Rose Lake provided an approximate eastern boundary. Indications were that the calving ground was similar to 1980 and as 2 days had been lost to bad weather, it was decided that the systematic reconnaissance should be carried out without further delay. Since most watersheds and eskers had a north-south orientation, transects were located in an east-west direction. The location of the first transect was randomly selected and adjacent transects were plotted at 9.6 km (6 mi) intervals on a 1:250,000 scale map (Fig. 1). Transects were extended 5-10 km beyond the known caribou concentration areas with the option of further extension if caribou were found to be present at the time of the survey.

By 1500 hrs on 8 June, weather conditions had improved to leave Itza Lake to begin the systematic reconnaissance. Transects A to D were flown under favourable observation conditions (95% high-cloud cover and 80-90% ground snow-cover) at an altitude of 400 m and an airspeed of 150 km/h before returning to Baker Lake.

The remaining transects E to L were flown on 9 June under fair to good conditions for observing caribou (90% high-cloud cover and 40-80% ground snow-cover).

During the systematic reconnaissance, all caribou 1 year of age and older were counted within the 0.4 km strip on each side of the aircraft which provided an 8.7% coverage of the area. Where possible individual animals were counted, otherwise they were counted by 5's, 10's, or 20's depending on the density of the groups between recorded observation points. Calves were recorded where they were evident but no effort was made to count calves and they are not included in the tabulation of caribou numbers. The proportion of yearlings was also noted in areas where they predominated. Bulls were identified by their short dark antlers and recorded where present.

Systematic Survey of the Calving Ground

The systematic reconnaissance provided adequate information to determine the boundaries of the calving ground and to delimit three strata of different densities. Survey effort for each stratum was based primarily on criteria developed by Heard (1980); high density areas received the greatest coverage to a maximum of 50% and low density areas had a minimum of 10 transects. Based on the amount of available aircraft time, length of transects and amount of coverage desired, the number of transects and spacing were determined. In each stratum, the first transect was randomly selected and adjacent transects evenly spaced to provide the

desired coverage. The low density Stratum I, had 10 transects spaced at 5.2 km for a 15.6% coverage, the medium density Stratum III, had 11 transects spaced at 2.0 km for a coverage of 39.3% and the high density Stratum II, had 26 transects at a spacing of 1.7 km for a coverage of 46.4% (Fig. 2).

Adverse weather conditions prevented flying on 10 June. On 11 June (high overcast, broken cloud-cover and 40-60% ground snow-cover), Strata I and III were flown, and on 12 June (sunny, clear and 40-50% ground snow-cover), Strata II was surveyed at the same altitude and airspeed as the systematic reconnaissance.

The aerial photography was carried out on the 12 and 13 June under clear conditions.

Ground Composition Counts

One of the recommendations from the 1980 survey was that ground composition counts to determine the proportion of breeding cows on the calving ground should be carried out during or immediately after the census to reduce the likelihood of caribou movements confounding the stratification. This was accomplished in 1982 with the ground counts being conducted from 12-16 June. A Bell 206B helicopter based at Itza Lake was used to fly Anne Gunn and Frank Miller to groups of caribou within each stratum. Caribou were located by flying at 50-150 m and airspeeds of 60-140 km/h. On sighting caribou at 1-5 km, the pilot manoeuvered the helicopter closer, using ridges and eskers as shields to land out of sight of the caribou. The two observers walked to the nearest

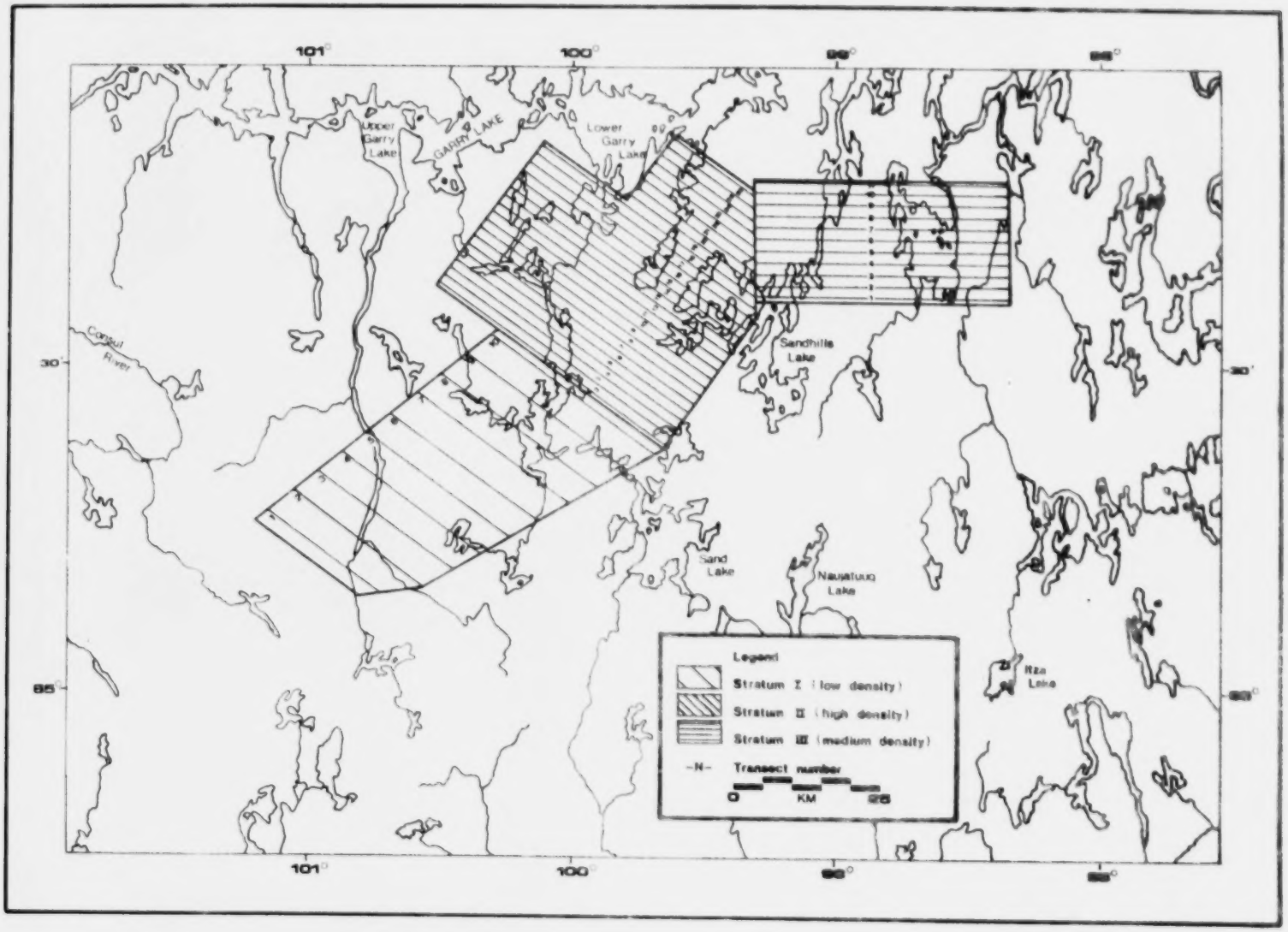


Figure 2. Beverly caribou calving ground and aerial survey transects in each of three density strata.

high ground to view the caribou from 200-400 m. One observer used a 20x spotting scope to examine the caribou and called the observations to the second observer. Caribou were classified as cows with calves, cows without calves - with or without distended udders, yearlings and juveniles (caribou judged to be larger than yearlings and to have forked velvet antlers). An attempt was made to classify all caribou in a group which were usually defined by topography except for distinct groups on lake surfaces.

The helicopter was also used to place the observers along a shoreline or peninsula and then fly 1-2 km behind the caribou to move them onto the ice to facilitate counting. The selection of groups was dictated by the terrain offering an undisturbed approach. If the caribou reacted by trotting or galloping, the approach was terminated.

Fall Composition Counts

The proportion of bulls, cows, yearlings and calves was determined from ground surveys conducted between 23 October and 14 November from a base camp at Forestry Lake. This survey will be covered in a separate report (Gunn in prep.).

RESULTS AND DISCUSSION

General Reconnaissance

Eight hours of flying time in 1 day was sufficient to establish the general location of the calving ground except for the southern boundary. This was possible because of the knowledge of caribou distribution gained during the past 4 years of monitoring the Beverly caribou calving grounds (Darby 1978, Darby 1980, Cooper 1981, Clement 1982), calving ground surveys in 1978 (Heard and Decker 1980) and 1980 (Gunn and Decker 1982), and ecological and behavioural research during the past 2 years (Fleck and Gunn 1982, Jingfors, Gunn and Miller 1982).

The flight to the south confirmed that caribou did not use a southern calving ground as they had prior to 1974 (Darby 1978). Caribou trails indicated that the northeast spring migration had crossed the Thelon River in the vicinity of Ursus Islands. Few caribou were seen in this area and no adult cows were evident.

By 5 June, most animals had passed the headwaters of Upper Garry River and the remaining caribou in this area were largely yearlings or young females. The majority of the cows were south of Garry Lake between Upper Garry River and Deep Rose Lake and south to Sand Lake (Fig. 1). This distribution was further north than in 1980 but otherwise fairly similar.

Systematic Reconnaissance

Fewer caribou were seen immediately south of Garry Lake (transect A, Fig. 1) than had been present during the general

reconnaissance. At that time caribou were seen moving in a southerly direction from the snow-free knolls south of the lake. The majority of the caribou were counted on transects B to D (Table 1). Few caribou were counted on the southern four transects (I-L) and the majority of these were yearlings. Adult cows were scarce and no calves were observed. The only bulls seen during the survey were on the most southerly transect. These four transects were considered to be south of the calving ground. The remaining transects (A-H) covered an area of 8327 km^2 but extended well beyond the boundaries of the calving ground as indicated by the absence of caribou. This area had an average density of 7.4 caribou/km^2.

Observations by both observers were recorded on a 1:250,000 scale map and densities calculated for 6 km sections of each transect. These densities were used to delimit three strata which had approximately 6, 12 and 24 caribou/km^2, respectively (Fig. 2). Low densities (1 caribou/km) at the end of transects (primarily yearlings) were excluded from the boundaries of the calving ground. The actual calving ground area (4219 km^2) was nearly half the area covered in the systematic reconnaissance (8327 km^2) and had twice the density 14.5 vs. 7.4 caribou/km^2) indicating that nearly all the caribou were within the designated calving ground.

The reconnaissance data were analyzed by strata to obtain a preliminary estimate of the calving ground population. The number of caribou counted on portions of each transect which were located in each designated stratum are shown in Table 2. The density of 23.5 caribou/km^2 in Stratum II was about four times that of

Table 1. Caribou counted on each transect during the systematic reconnaissance survey of the Beverly caribou calving ground on 8-9 June, 1982.

Transect No.	Transect Length (km)	Transect Area (km^2)	Caribou counted Left observer	Caribou counted Right observer	Caribou counted Total	Density (caribou/km^2)
A	111	88.8	122	65	187	2.1
B	129	103.2	721	698	1419	13.8
C	127	101.6	947	1170	2117	20.8
D	106	84.8	309	377	686	8.1
E	117	93.6	106	126	232	2.5
F	93	74.4	84	106	190	2.6
G	116	92.8	134	165	299	3.2
H	106	84.8	110	117	227	2.7
Total	905	724.0	2533	2824	5357	7.4
*I	108	86.4	62	73	135	1.6
J	60	48.0	44	32	76	1.6
K	69	52.2	10	16	26	0.5
L	48	38.4	33	77	110	2.9

* Few adult cows and no newborn calves were seen on transects I-L. These lines were considered to be south of the calving ground.

Area surveyed (A-H) = 8327 km^2.

Table 2. Caribou numbers and densities in the three strata from the systematic reconnaissance survey of the Beverly caribou calving ground on 8-9 June, 1982.

	Transect		Caribou	
No.	Length (km)	Area (km^2)	Number	Density
Stratum I ($1508\ km^2$)				
E	28	22.4	155	6.9
F	54	43.2	179	4.1
G	51	40.8	278	6.8
H	31	24.8	173	7.0
Total	164	131.2	785	6.0
Stratum II ($1771\ km^2$)				
A	31	24.8	144	5.8
B	46	36.8	985	26.8
C	54	43.2	1770	41.0
D	40	32.0	647	20.2
E	20	16.0	40	2.5
Total	191	152.8	3586	23.5
Stratum III ($940\ km^2$)				
B	43	34.4	392	11.4
C	43	34.4	339	9.9
Total	86	68.8	731	10.6

Stratum I as suggested in the preliminary analysis of the reconnaissance data. Based on the systematic reconnaissance a total calving ground population estimate of 60,570±14,207 (S.E.) was obtained (Table 3). The low sampling effort of 8.4% resulted in a relatively high coefficient of variation of 24% and wide 95% confidence limits of 29,000 to 92,000 caribou on the calving ground.

Systematic Survey of the Beverly Calving Ground

The number of caribou and their density on each transect are presented for the three strata in Appendix A. There were fewer caribou in Stratum II and more in Stratum III during the systematic survey than during the reconnaissance survey (Table 4). This was evident on 11 June when high densities were encountered on the west portion of Stratum III (Fig. 3) indicating an easterly shift of caribou within the calving ground during the 2 days between the surveys in this area. Temperatures had moderated by 11 June and open water was present in low-lying areas. Caribou were seen frequently feeding and wading in ponds and creeks while previously they appeared to be feeding only on the limited snow-free areas.

A calving ground population estimate of 55,660±5,810 was derived from the systematic survey (Table 5). This estimate is within 10% of the reconnaissance survey estimate but has a much smaller variance as would be expected from the increased coverage of the stratified sampling. There is a 95% chance that the calving ground population was between 44,000 and 67,000.

Table 3. Beverly caribou calving ground population estimate based on the systematic reconnaissance survey, 8-9 June, 1982.

Stratum	Area km^2	Possible transects	Surveyed transects	Area sampled km^2	Caribou counted	Density (caribou/ km^2)	Calving ground estimate	Variance	Standard error	Coefficient of variation
I	1,508	58	4	131.2	785	6.0	9,025	2,221,221	1,490	0.17
II	1,771	69	5	152.8	3,586	23.5	41,558	199,103,430	14,110	0.34
III	940	28	2	68.8	731	10.6	9,991	511,238	715	0.07
Total	4,219	155	11	352.8	5,102	14.5	60,574	201,835,889	14,207	0.24

Population estimate ± 95% confidence intervals = 60,570 ± 31,650.

Table 4. A comparison of the density per stratum between the reconnaissance and systematic surveys of the Beverly herd, 1982.

Stratum	Caribou density	
	Reconnaissance survey (caribou/km^2)	Systematic survey (caribou/km^2)
I	6.0	6.7
II	23.5	18.5
III	10.6	13.6

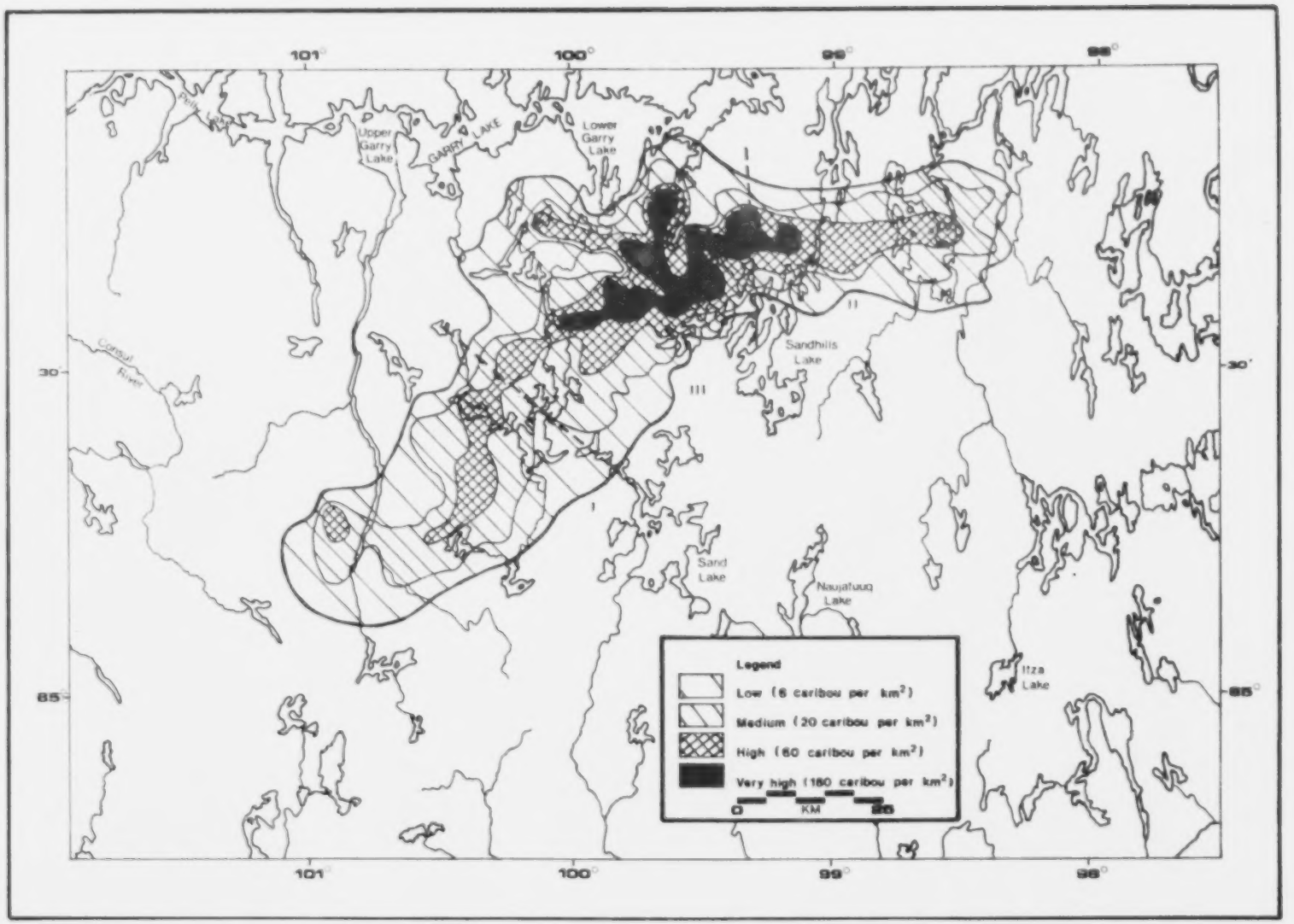


Figure 3. Distribution of different density components of the Beverly caribou calving ground population as determined from aerial surveys on 11-12 June, 1982.

Table 5. Beverly caribou calving ground estimate based on the systematic survey of three density strata, 11-12, June, 1982.

Stratum	Area km^2	Possible transects	Surveyed transects	Area sampled km^2	Caribou counted	Density (caribou/ km^2)	Calving ground estimate	Variance	Standard error	Coefficient of variation
I	1,508	64	10	240.2	1,619	6.7	10,166	4,203,849	2,050	0.20
II	1,771	56	26	826.6	15,280	18.5	32,734	21,309,352	4,616	0.14
III	940	28	11	378.4	5,136	13.6	12,763	8,221,822	2,967	0.23
Total	4,219	148	47	1,445.2	22,035	15.2	55,663	33,735,023	5,808	0.10

Population estimate ± 95% confidence intervals = 55,660 ± 11,380.

Ground Composition Counts

Caribou were classified at 53 sampling locations within the three strata. The composition counts for each location are presented in Appendix B. A total of 3,768 caribou was classified with the majority in the high density Stratum II (Table 6).

The proportion of breeding females ranged from 85% in the high density stratum to 55% in the low density area (Table 7). For the entire calving ground breeding females comprised 77.4% (43,083) of the caribou over 1 year of age. This was higher than in 1980 (70.8%) (Gunn and Decker 1982) but the difference was not significant. Nearly 9% of the cows that had produced calves had lost their calves by the middle of June.

Yearlings comprised 34% of the caribou in the low density stratum and averaged 17.4% on the calving ground. This was higher than in 1980 when yearlings comprised 13.2% of the caribou on the calving ground.

Fall Composition Counts

Of the 7,653 caribou classified on the winter range there were 828 prime bulls, 1,053 young bulls, 699 yearlings, 3,323 cows and 1,750 calves. If half the yearlings were females there were 3,673 cows in the sample of 5,903 caribou over 1 year of age. This indicates that adult females comprised 62.2% of the Beverly caribou population in 1982. This percentage is slightly lower than the 1981 figure of 63.5% but considerably higher than the 1980 figure of 56.7%.

Table 6. Sex and age composition of caribou sampled on three strata on the Beverly calving ground, 12-16 June, 1982.

Stratum	Cows			Yearlings	Juveniles	Total
		Without calves				
	With calves	Udders	No udders			
High - II	1558	115	45	238	18	1974
Medium - III	805	98	19	211	46	1179
Low - I	298	43	47	208	19	615
Total	2661	256	111	657	83	3768

Table 7. Percentages of breeding cows, non-breeding cows, yearlings, and juveniles on the Beverly calving ground, 12-16 June, 1982.

Stratum	Breeding cows	Non-breeding cows	Yearlings	Juveniles
High - II	84.8	2.3	12.1	0.9
Medium - III	76.6	1.6	17.9	3.9
Low - I	55.4	7.6	33.8	3.1
Total	77.4	2.9	17.4	2.2

The calf:cow ratio was 1,250:3,673 or 47.6 calves per 100 cows. This represents a 67.7% survival of calves from early June to early November.

Total Population Estimate

An estimate of the total population was derived from the proportion of females in the population, the proportion of those females which breed and the number of breeding females on the calving ground.

The number of breeding females on the calving ground was obtained by correcting the calving ground population (55,660, Table 5) for observer bias (1.25, Heard 1981) and multiplying by the proportion of breeding females on the calving ground (0.774, Table 7). This figure was then divided by the product of the proportion of females in the total population (0.622, 1982 fall composition count) and the proportion of females breeding (0.694, Dauphine 1976) to give a total population estimate.

Each variable in this formula has an associated sampling error which should be used to assess the confidence of the estimate. However, the variances of four parameters were not determined, although they have been approximated on previous surveys (Heard and Decker 1980, Heard 1981, Gunn and Decker 1982). A minimum confidence interval can be obtained by calculating the 95% confidence interval of the calving ground estimate ($\pm$ 11,380, Table 4) and assuming the variance of all other variables was zero.

$$\text{Total population estimate} = \frac{(55660 \pm 11380)\ (1.25)\ (0.774)}{(0.622)\ (0.694)}$$

$$= (55660 \pm 11380)\ (2.24)$$

$$= 124{,}700 \pm 25{,}500$$

This indicates that the 1982 Beverly caribou population was between 99,000 and 150,000 with a mean estimate of approximately 125,000.

Observer Bias

Caribou were not randomly distributed throughout the calving ground but tended to group into aggregations of different density (Fig. 3). Many of the larger groups were on the move when encountered on our surveys and accounted for high numbers being recorded over short sections of the transect or on one side of a transect.

On the reconnaissance survey the right observer (Decker) counted 11% more caribou than the left oberver (Stephenson) while on the systematic surveys of the three strata, the left observer consistently counted more caribou. The main difference was that more concentrated groups were encountered on the left side of the aircraft (Appendix A). For example in one 6 km section (Stratum II, line 14) the left observer counted 1235 caribou at a density of 500/km^2 while the right observer counted only 150 caribou. At the time both observers were aware of the situation. Such differences are largely attributed to chance and not to observer bias.

Other factors could have influenced the count, the most critical being strip width. The width is largely determined by the height of the aircraft but when flying over irregular terrain it is difficult for the pilot to maintain an elevation of 122 m above ground level. Fortunately, we had a good pilot but occasionally a 30 m discrepancy was noted. In those instances, the observers subjectively compensated by including or excluding caribou from the observation strip. Similar compensations were made to counteract for the yaw of the aircraft and to adjust for a sagging wing-strut marker. Generally, the observations were made straight out from the side of the aircraft and not forward where the proper mark on the wing-strut could be seen. Occasionally, there was a problem with the inside edge of the observation zone, especially if the aircraft was quartering in a wind, or if caribou reacted by moving in or out of the transect.

Although errors were inevitable by estimating segments of large concentrations it is doubtful if this bias was as great as the potential error associated with strip width. It is expected that a comparison of the aerial photographic survey with the visual survey will provide a measure of observer bias although it will not indicate where the bias originated.

Timing of Calving

Few calves were observed on 5 June but they were quite evident on 8-9 June during the systematic reconnaissance. The majority of cows had calves with them by 11-12 June. Helicopter

and ground observation by the research team indicated that calf/cow ratios were 56/100 between 9-10 June in the high density stratum and between 11-12 June in the medium density stratum. On 13 June the ratio was 85 calves/100 cows in the combined strata indicating that the peak of calving was between 10-13 June.

Observations of Other Mammals

Seventeen wolves (Canis lupus) were observed during the aerial surveys of which six were within the delimited calving ground (one single and packs of 2 and 3). The majority of the others were southwest of the calving ground along the spring migration route (three singles and packs of 3 and 5). The pack of five was at a large caribou carcass and the wolves were reluctant to leave when the aircraft passed overhead.

One adult grizzly bear (Ursus arctos) was observed at the southwest edge of Stratum I. No caribou were within 1-2 km of the bear.

One of the two arctic foxes (Alopex lagopus) seen still had its white winter coat while the other was moulting.

A total of 112 adult muskoxen (Ovibos moschatus) was seen of which 41 were within the calving ground south of Garry Lake. The largest herd of 65 adults plus an undetermined number of calves was observed immediately southeast of Stratum I. The second large herd south of Garry Lake contained 35 adults. The remaining muskoxen were in groups of 2, 3, 3, and 4.

Two arctic hares (Lepus arcticus) were also noted in separate locations.

RECOMMENDATIONS

An estimate of the Beverly caribou calving ground population should continue to be obtained every second year. If aerial photography proves to be cost-effective and provides better results, then it should replace the systematic survey of the calving ground in 1984. However, the visual systematic reconnaissance survey should be carried out to delimit the calving ground and sampling strata, and to provide an estimate of the population. Experienced observers should be used.

Efforts should be extended to reduce observer error associated with strip widths. Strut-markers should be rigidly fixed to indicate the proper zone for observation behind the strut. Aircraft altitude could be more closely maintained if a radar altimeter were used rather than using elevation estimates from a topographic map; at least these estimates should be pre-recorded on the navigator's map to assist the pilot in maintaining the proper elevation.

The composition of the calving ground population and the total fall population vary annually and should continue to be assessed in association with every population survey. Also the age-specific pregnancy rate should be assessed for the Beverly herd. There is some indication from CWS studies that it is higher than the figure commonly used (D. Thomas pers. comm.). The variability in sampling these parameters results in a rather crude estimate of the total population and may preclude any statistical support for observed population changes. Emphasis should be

placed on the numbers of breeding females on the calving ground as an index to population changes rather than the calving ground population as in earlier surveys.

ACKNOWLEDGEMENTS

The competent services of Norm Zigarlic of Loon Air, Fort Smith, as both a pilot and navigator during the aerial surveys is gratefully appreciated. We acknowledge the participation of Gibson Taipana, a Baker Lake Hunters' and Trappers' Association representative, in the aerial reconnaissance surveys, and Frank Miller, Canadian Wildlife Service, in the ground composition counts. Field accommodation was provided by the joint N.W.T. Wildlife Service - Canadian Wildlife Service research camp at Itza Lake, and Heather Clement graciously provided our accommodation at Baker Lake. Mark Cattet drafted the figures and Ellen Christensen typed the report.

LITERATURE CITED

Clement, H. 1982. Beverly and Kaminuriak caribou monitoring and land-use controls, 1981. N.W.T. Wildl. Serv. Prog. Rep. No. 6. 49 pp.

Cooper, S. 1981. Beverly and Kaminuriak caribou monitoring and land use controls, 1980. N.W.T. Wildl. Serv. Prog. Rep. No. 4. 74 pp.

Darby, W.R. 1978. Beverly and Kaminuriak caribou monitoring and land use controls, 1978. N.W.T. Wildl. Serv. Comp. Rep. No. 1. 83 pp.

Darby, W.R. 1980. Beverly and Kaminuriak caribou monitoring and land use controls, 1979. N.W.T. Wildl. Serv. Prog. Rep. No. 3. 74 pp.

Dauphine, T.C. 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 4. Growth, reproduction and energy reserves. Can. Wild. Serv. Rep. Ser. 38. 65 pp.

Fleck, E.S. and A. Gunn. 1982. Characteristics of three barren-ground caribou calving grounds in the Northwest Territories. N.W.T. Wildl. Serv. Prog. Rep. No. 7. 158 pp.

Gunn, A. and R. Decker. 1982. Survey of the calving grounds of the Beverly caribou herd, 1980. N.W.T. Wildl. Serv. File Rep. No. 20. 27 pp.

Heard, D.C. 1980. Allocation of effort in a stratified survey design. N.W.T. Wildl. Serv. unpubl. rep. 8 pp.

Heard, D.C. 1981. An estimate of the size and structure of the Kaminuriak caribou herd in 1977. N.W.T. Wildl. Serv. File Rep. No. 17. 37 pp.

Heard, D.C. and R. Decker. 1980. An estimate of the size and structure of the Beverly caribou herd, 1978-79. N.W.T. Wildl. Serv. unpubl. rep. 40 pp.

Jingfors, K., A. Gunn, and F.L. Miller. 1982. Behaviour and range use patterns of caribou on the Beverly calving ground, N.W.T. N.W.T. Wildl. Serv. File Rep. No. 22. 118 pp.

Appendix A. Caribou numbers and densities in three Strata from the systematic survey of the Beverly calving ground on 11-12 June, 1982.

Table 1. Caribou numbers and densities in Stratum I from the systematic survey of the Beverly calving ground on 11 June, 1982.

Transect			Caribou counted			Density
No.	Length (km)	Area (km^2)	Left observer	Right observer	Total	(caribou/ km^2)
1	23.5	18.8	23	36	59	3.1
2	27.0	21.6	69	92	161	7.5
3	28.3	22.6	21	31	52	2.3
4	29.3	23.4	61	34	95	4.1
5	30.0	24.0	35	46	81	3.4
6	31.0	24.8	177	71	248	10.0
7	31.5	25.2	65	57	122	4.8
8	32.5	26.0	149	121	270	10.4
9	33.3	26.6	62	40	102	3.8
10	34.0	27.2	268	161	429	15.8
Total	300.4	240.3	930	689	1619	6.7

Table 2. Caribou numbers and densities in Stratum II from the systematic survey of the Beverly calving ground on 12 June, 1982.

Transect			Caribou counted			Density
No.	Length (km)	Area (km^2)	Left observer	Right observer	Total	(caribou/ km^2)
1	47.5	38.0	109	95	204	5.4
2	47.5	38.0	26	33	59	1.6
3	47.5	38.0	49	147	196	5.2
4	47.5	38.0	159	32	191	5.0
5	47.5	38.0	123	155	278	7.3
6	47.5	38.0	442	170	612	16.1
7	47.5	38.0	122	166	288	7.6
8	47.5	38.0	147	203	350	9.2
9	47.5	38.0	106	377	483	12.7
10	47.5	38.0	610	174	784	20.6
11	47.5	38.0	111	392	503	13.2
12	47.5	38.0	595	164	759	20.0
13	47.5	38.0	209	240	449	11.8
14	47.5	38.0	1820	407	2227	58.6
15	47.5	38.0	772	683	1455	38.3
16	47.5	38.0	346	335	681	17.9
17	47.0	37.6	144	162	306	8.1
18	45.8	36.6	708	919	1627	44.5
19	27.0	21.6	397	468	865	40.0
20	25.8	20.6	1170	642	1812	88.0
21	24.5	19.6	274	248	522	26.6
22	23.3	18.6	156	120	276	14.8
23	22.0	17.6	98	41	139	7.9
24	20.8	16.6	59	84	143	8.6
25	19.3	15.4	23	26	49	3.2
26	18.0	14.4	11	11	22	1.5
Total	1033.5	826.6	8786	6494	15280	18.5

Table 3. Caribou numbers and densities in Stratum III from the systematic survey of the Beverly calving ground on 11 June, 1982.

Transect			Caribou counted			Density
No.	Length (km)	Area (km^2)	Left observer	Right observer	Total	(caribou/ km^2)
1	43.0	34.4	16	20	36	1.0
2	43.0	34.4	33	25	58	1.7
3	43.0	34.4	52	98	150	4.4
4	43.0	34.4	185	91	276	8.0
5	43.0	34.4	383	239	622	18.1
6	43.0	34.4	550	756	1306	38.0
7	43.0	34.4	595	555	1150	33.4
8	43.0	34.4	482	211	693	20.1
9	43.0	34.4	194	284	478	13.9
10	43.0	34.4	180	46	226	6.6
11	43.0	34.4	36	105	141	4.1
Total	473.0	378.4	2706	2430	5136	13.6

Appendix B. Composition counts at 53 locations on the Beverly calving ground, June, 1982.

Date	Location point	Cows with udders: with calves	Cows with udders: without calves	Cows without udders	Yearlings	Juveniles
Low density-Stratum I						
12 June	1				20	2
	2	1		1	8	1
	3	2	3	6	10	3
	4	1	4	1	3	1
	5	0	0	6	21	4
	6	10	4	1	4	0
	7	11	7	7	6	2
	8	7	2	1	8	0
	9	4	2	4	4	0
	10	9	1	2	1	0
	11	10	1	0	10	0
	12	30	4	4	4	0
13 June	24	0	0	3	20	1
	25	1	1	2	5	3
	26	0	0	3	43	0
	27	212	14	6	41	2
Total		298	43	47	208	19
High density-Stratum II						
12 June	13	36	4	1	4	0
	14	0	2	2	0	0
	15	45	2	0	10	0
	16	25	8	1	6	0
	17	20	2	2	9	0
	18	62	0	0	0	0
	19	32	9	1	26	1
13 June	20	82	21	17	52	5
	21	103	15	6	36	2
	22	117	8	3	11	2
	23	2	0	3	11	1

Appendix B. continued

Date	Location point	Cows with udders: with calves	Cows with udders: without calves	Cows without udders	Yearlings	Juveniles
16 June	46	93	2	0	5	1
	47	246	15	1	7	0
	48	207	4	2	1	0
	49	17	16	5	45	4
	50	224	5	0	9	2
	51	37	1	0	0	0
	52	58	0	0	3	0
	53	152	1	1	3	0
Total		1558	115	45	238	18
Medium density-Stratum III						
14 June	28	32	1	2	12	0
	29	10	3	1	8	0
	30	24	1	0	5	0
	31	39	1	0	3	0
	32	47	6	2	13	0
	33	31	3	1	3	0
	34	28	3	0	10	0
	35	45	21	0	14	0
	36	231	33	3	34	26
15 June	37	1	1	1	12	0
	38	1	0	1	13	0
	39	0	3	2	14	1
	40	7	6	1	26	4
	41	6	1	0	8	0
	42	186	9	0	15	7
	43	4	3	0	6	6
	44	26	1	0	11	2
	45	87	2	5	4	0
Total		805	98	19	211	46